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CHANGING LIVES IMPROVING LIFE

Torrefaction of Biomass to Enhance Fuel Properties

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Introduction

Depleting fossil fuel resources and GHG/Global Warming

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Renewable energy, sustainable fuels

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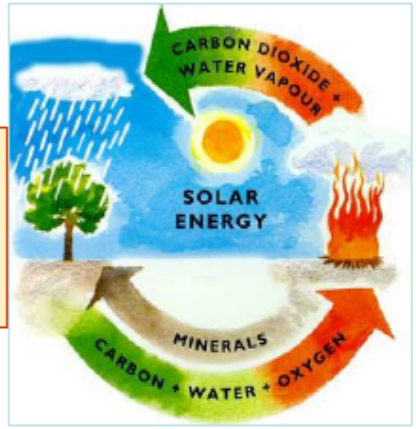
Biomass ➲ Carbon-neutral, local fuel; energy security



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Technology barriers to their utilization as energy source

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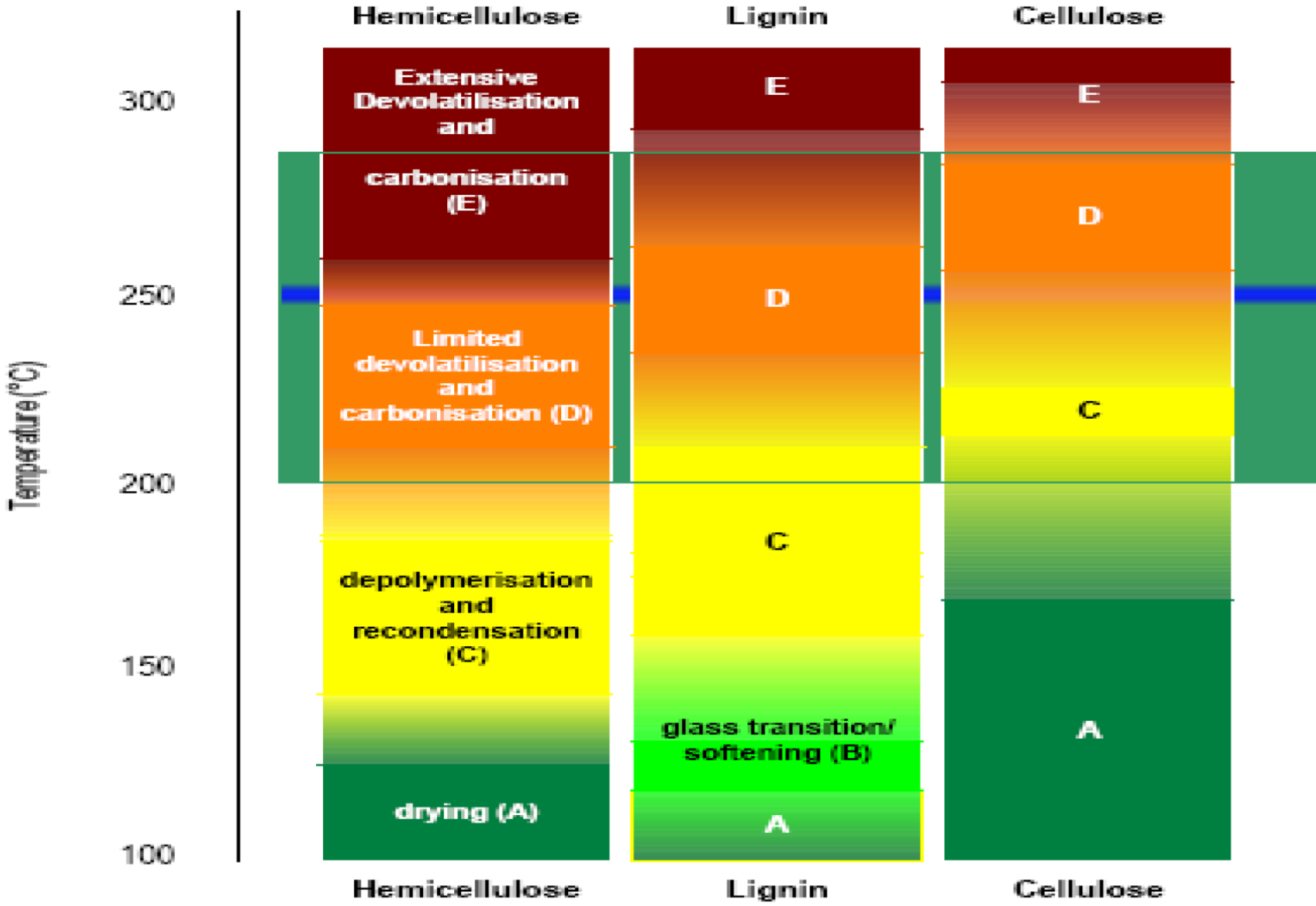
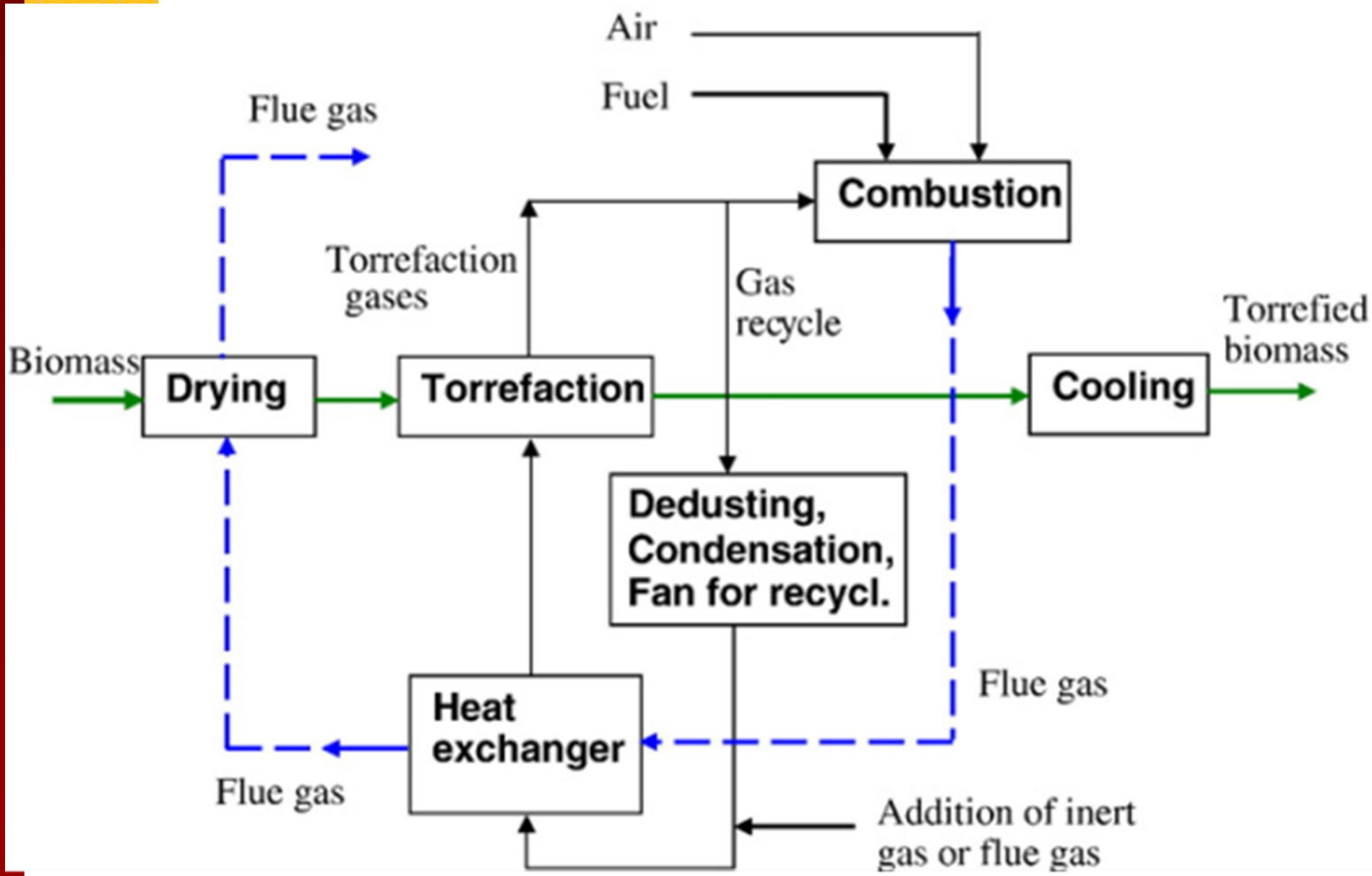
Torrefaction

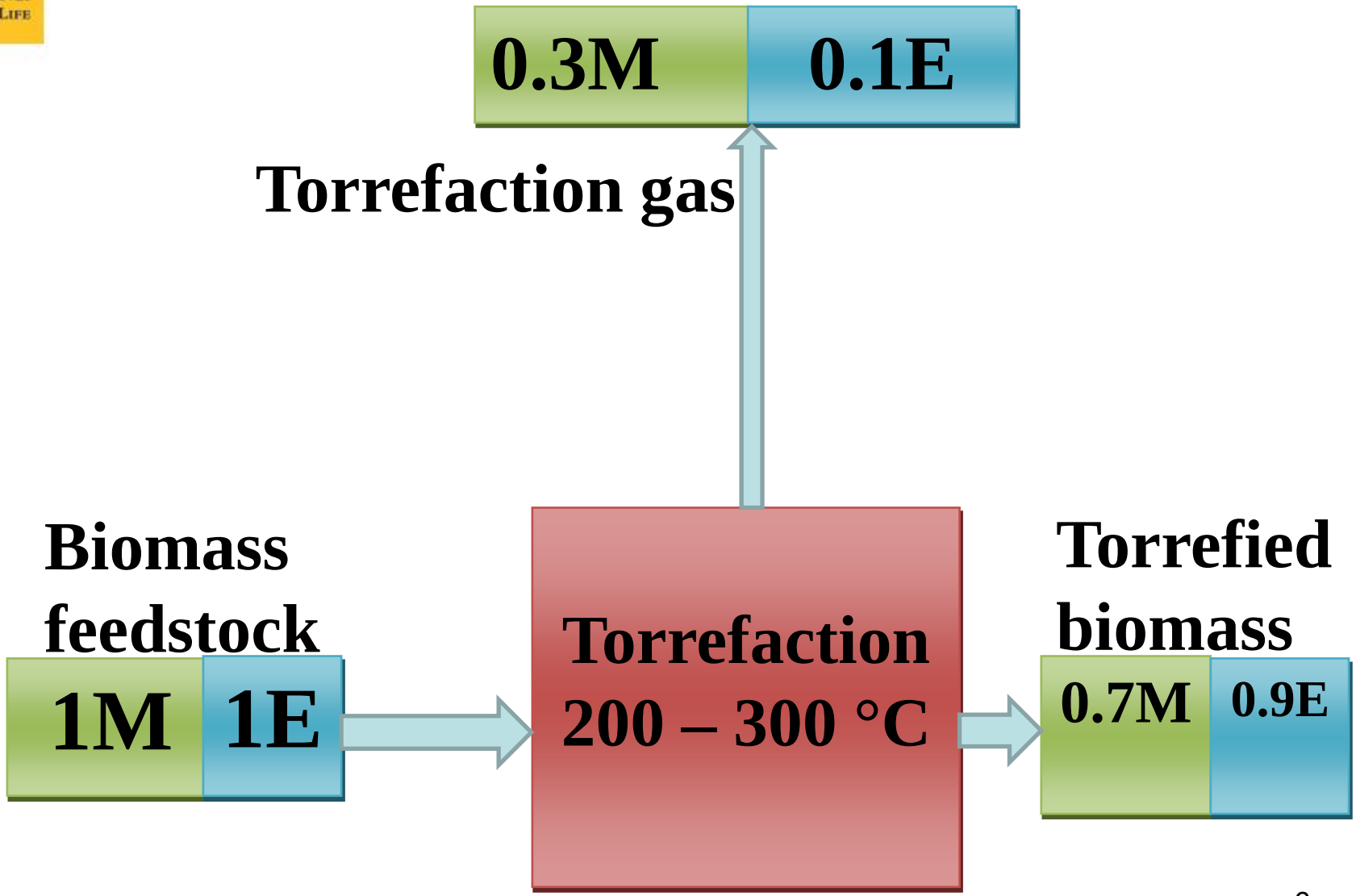
Introduction[2]



Torrefaction Process Concept



Introduction



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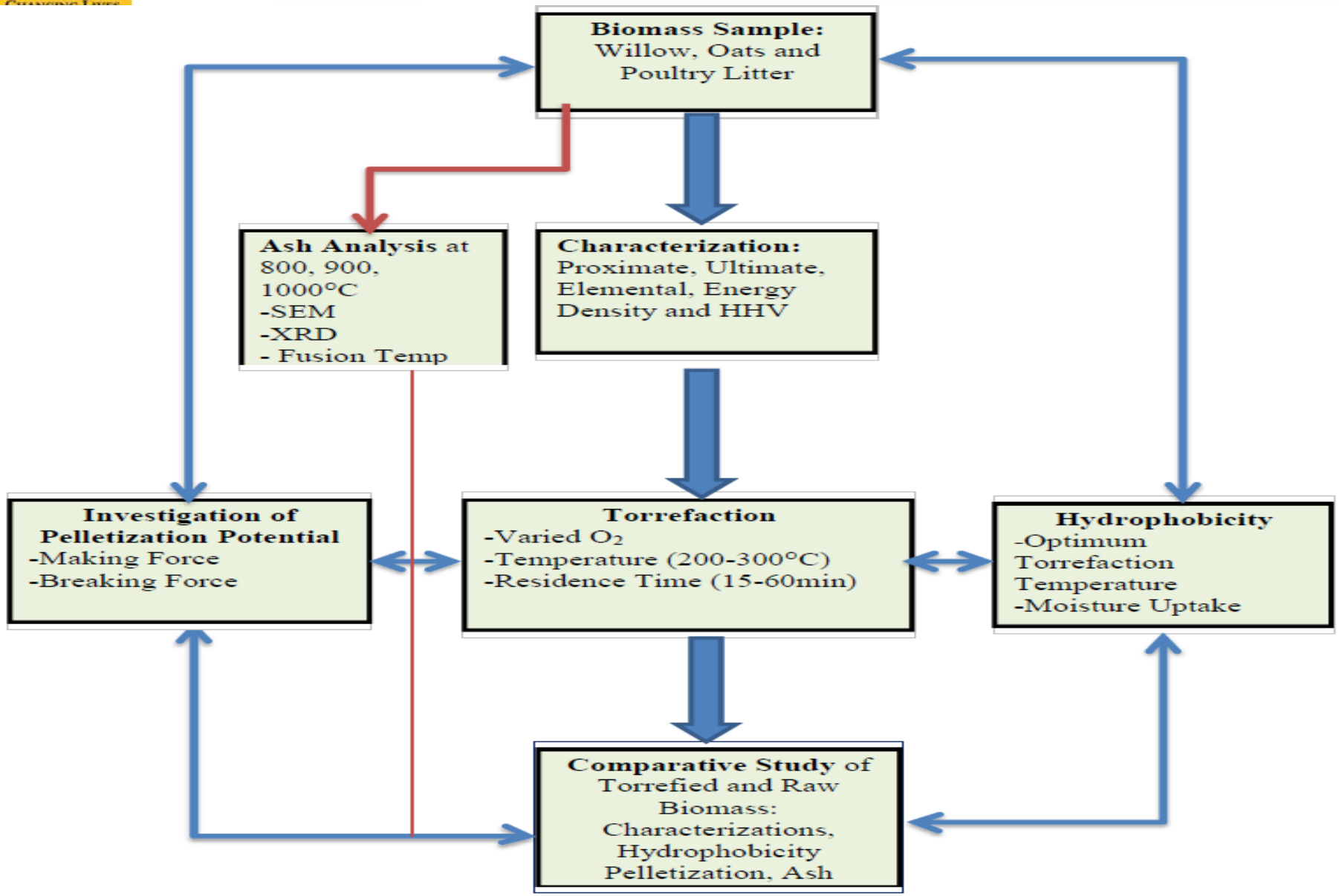
Objectives

- Study of Different characterizations of Lignocellulosic and Non-lignocellulosic biomass from Ontario before and after torrefaction.
- Optimization of torrefied conditions based on hydrophobicity
- Investigation of pelletization potential before and after torrefaction
- Ash analysis of biomass at different combustion temperature.

Methodology



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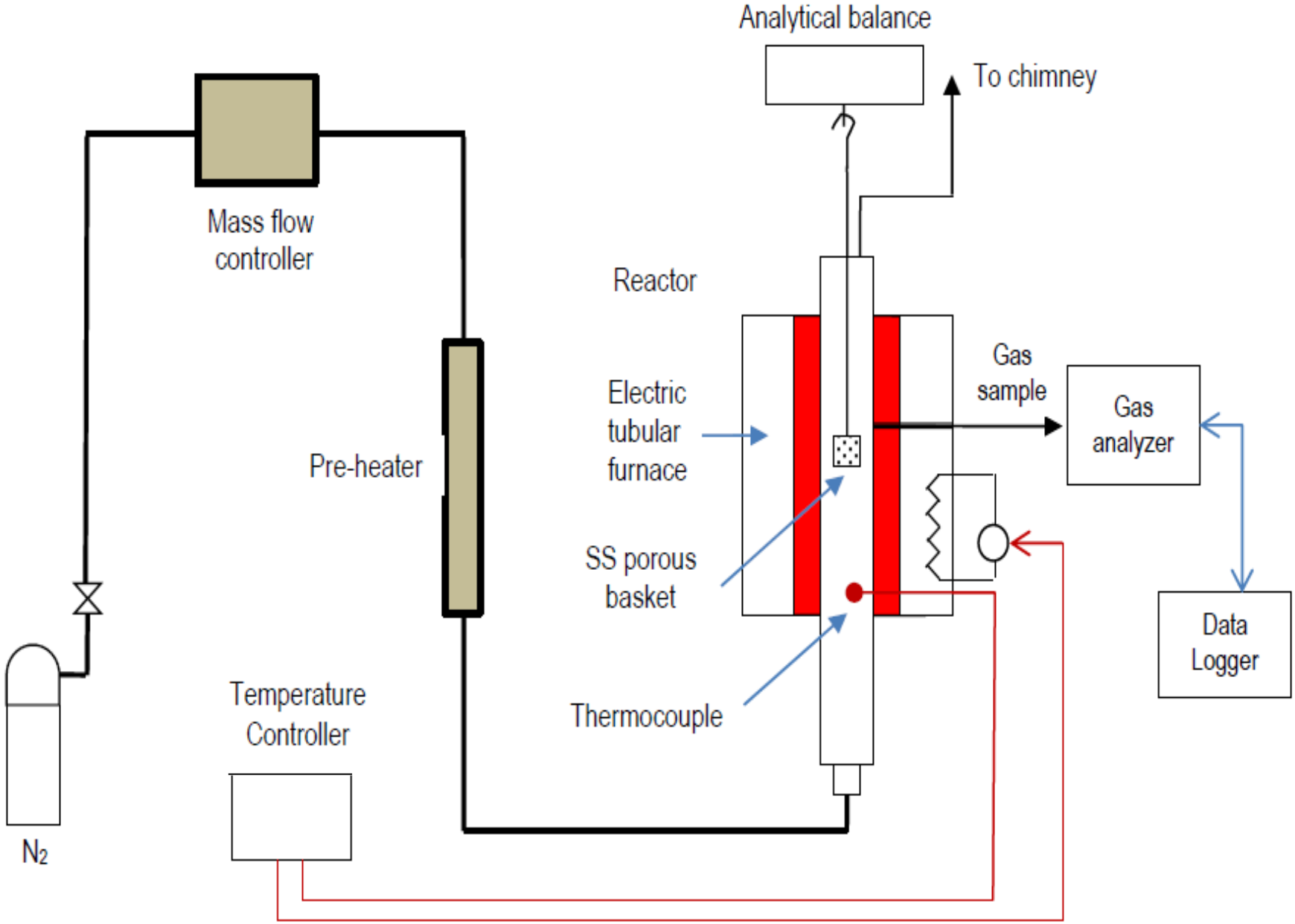
Experimental Set up (Drying + Proximate)

- Apparatus:
  - Programmable Muffle Furnace
  - Thermocouple with stainless steel probe
  - Crucible
  - Desiccator
  - Weighing Balance

Experimental Set up (Torrefaction)



Experimental Set up (Torrefaction)

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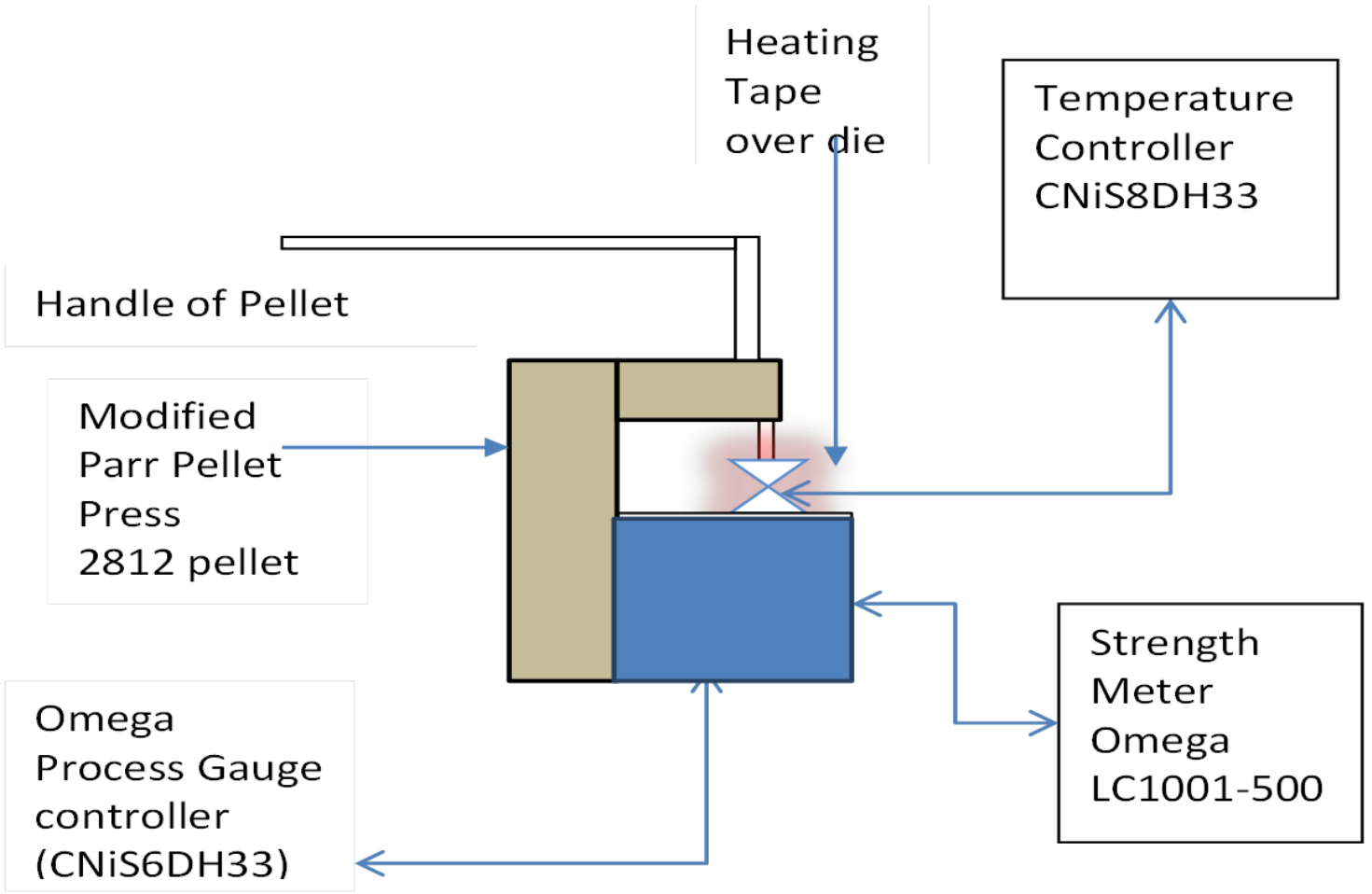
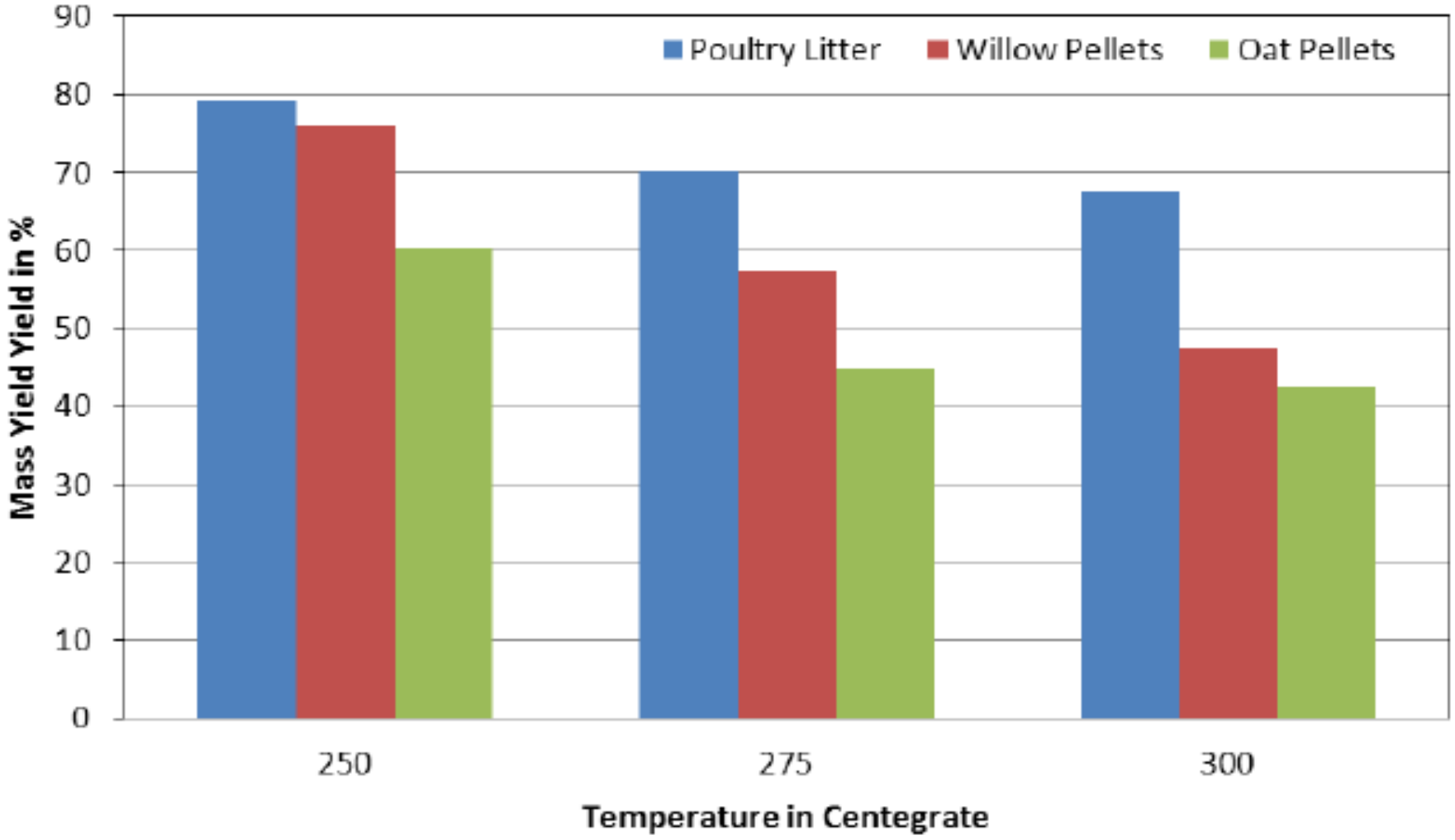
Apparatus:

- Locally designed and fabricated Reactor
- Connecting cables and fittings
- N2 gas
- Gas Analyzer
- Preheater
- Gas Flow Meter
- Thermocouples
- Temperature Controllers (2)
- Desiccator
- Electric weigh balance

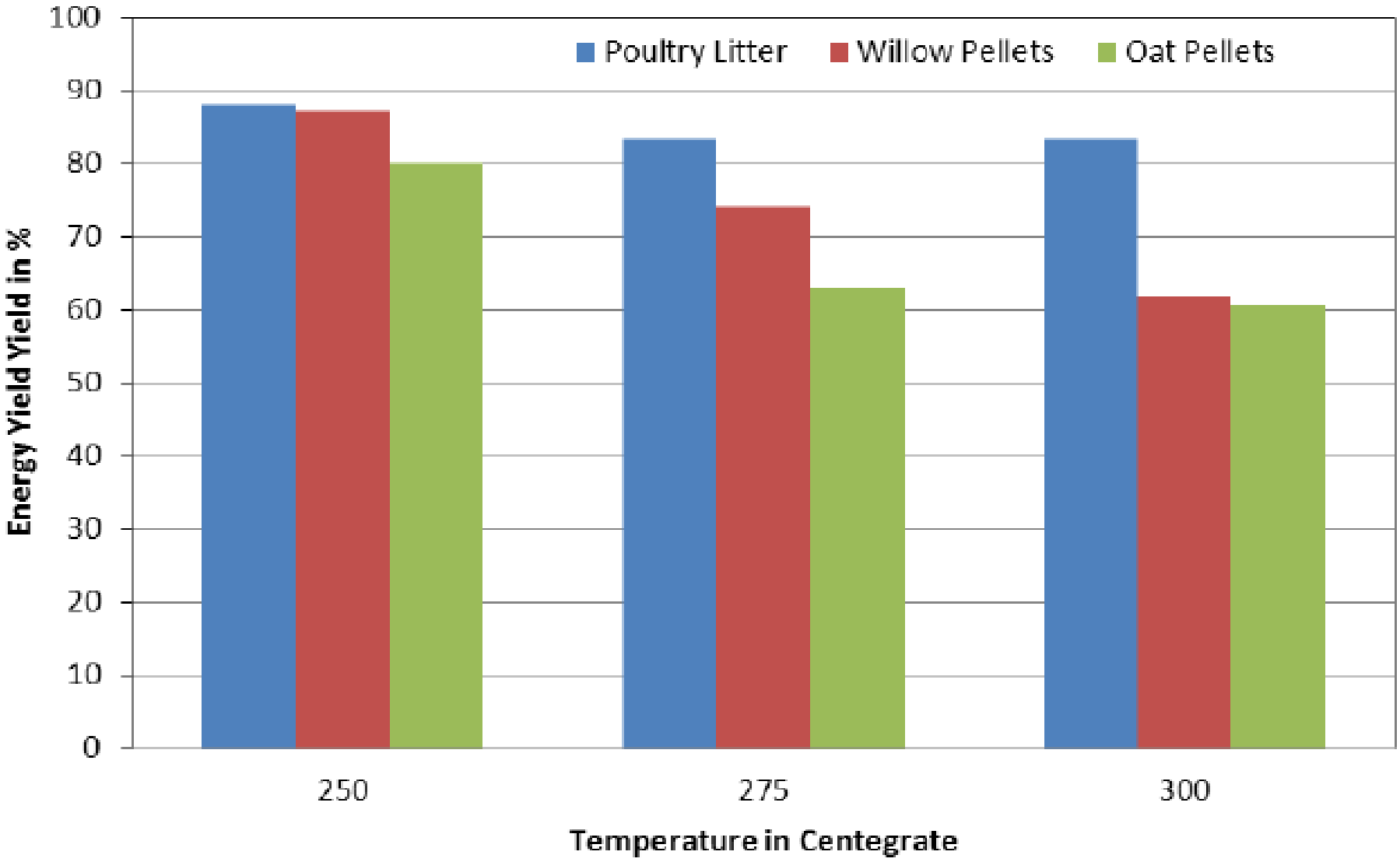
Experimental Set up (Pelletization)



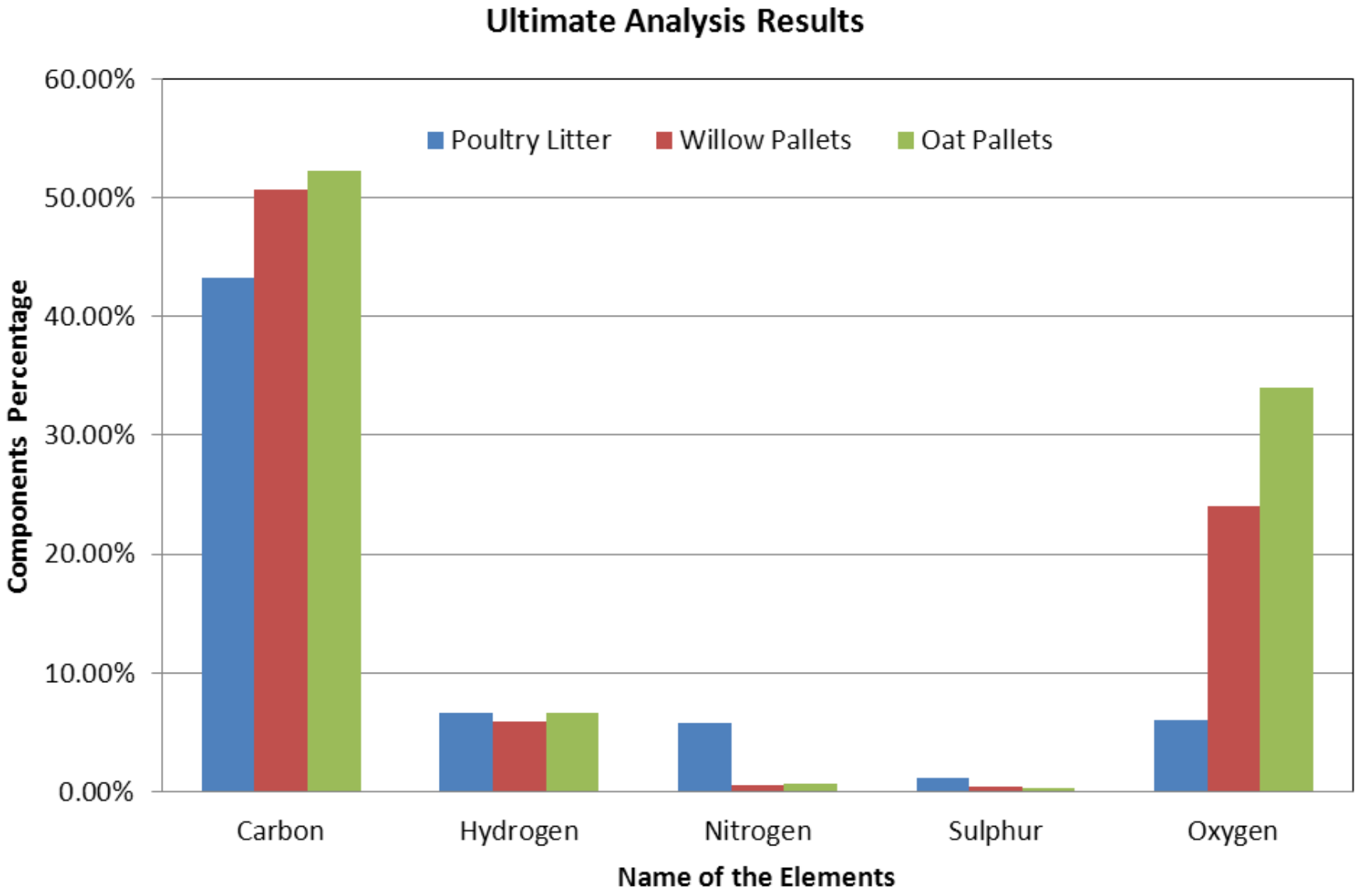
Experimental Result (Proximate analysis)



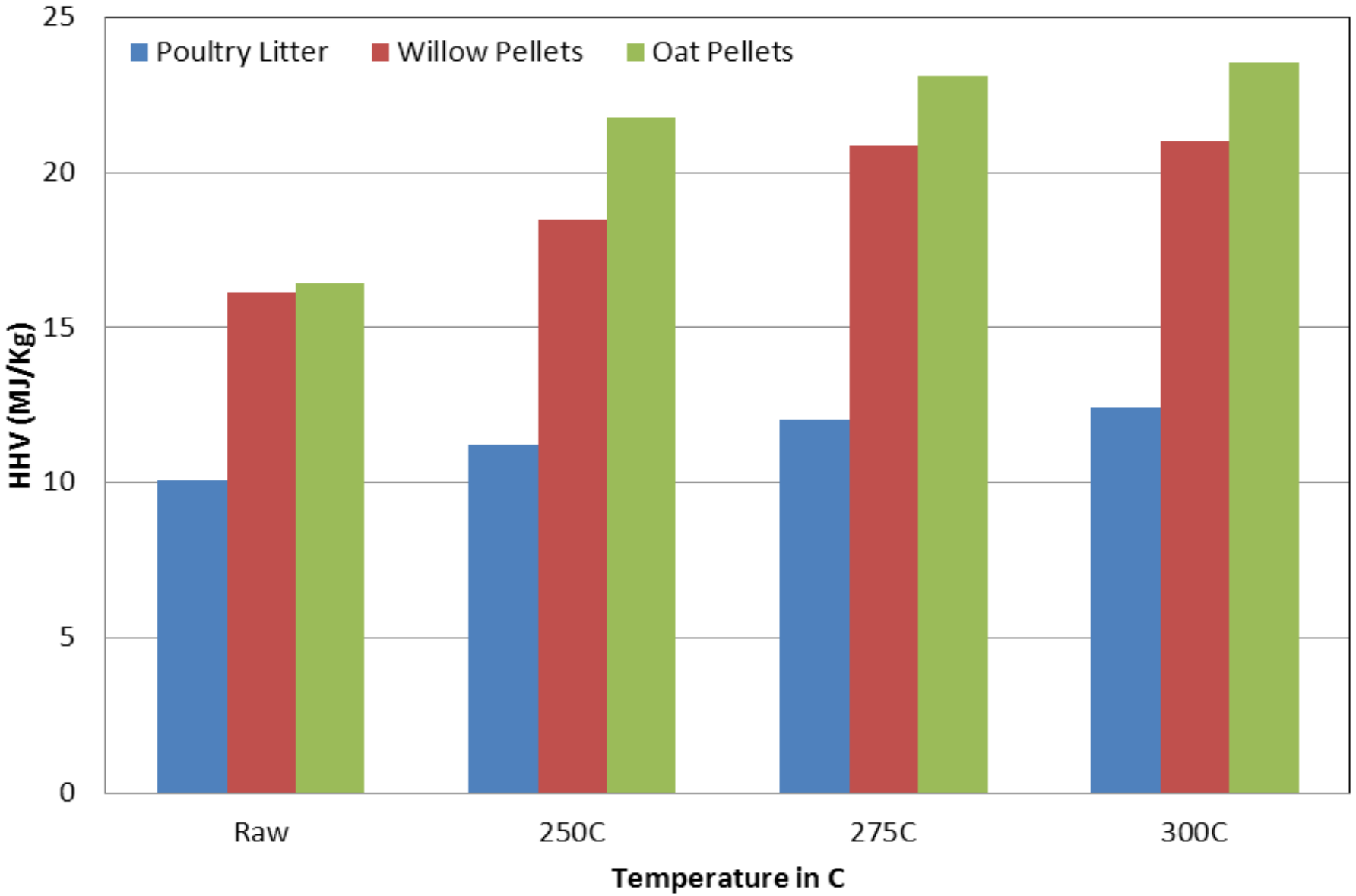
Experimental Result (Proximate analysis)



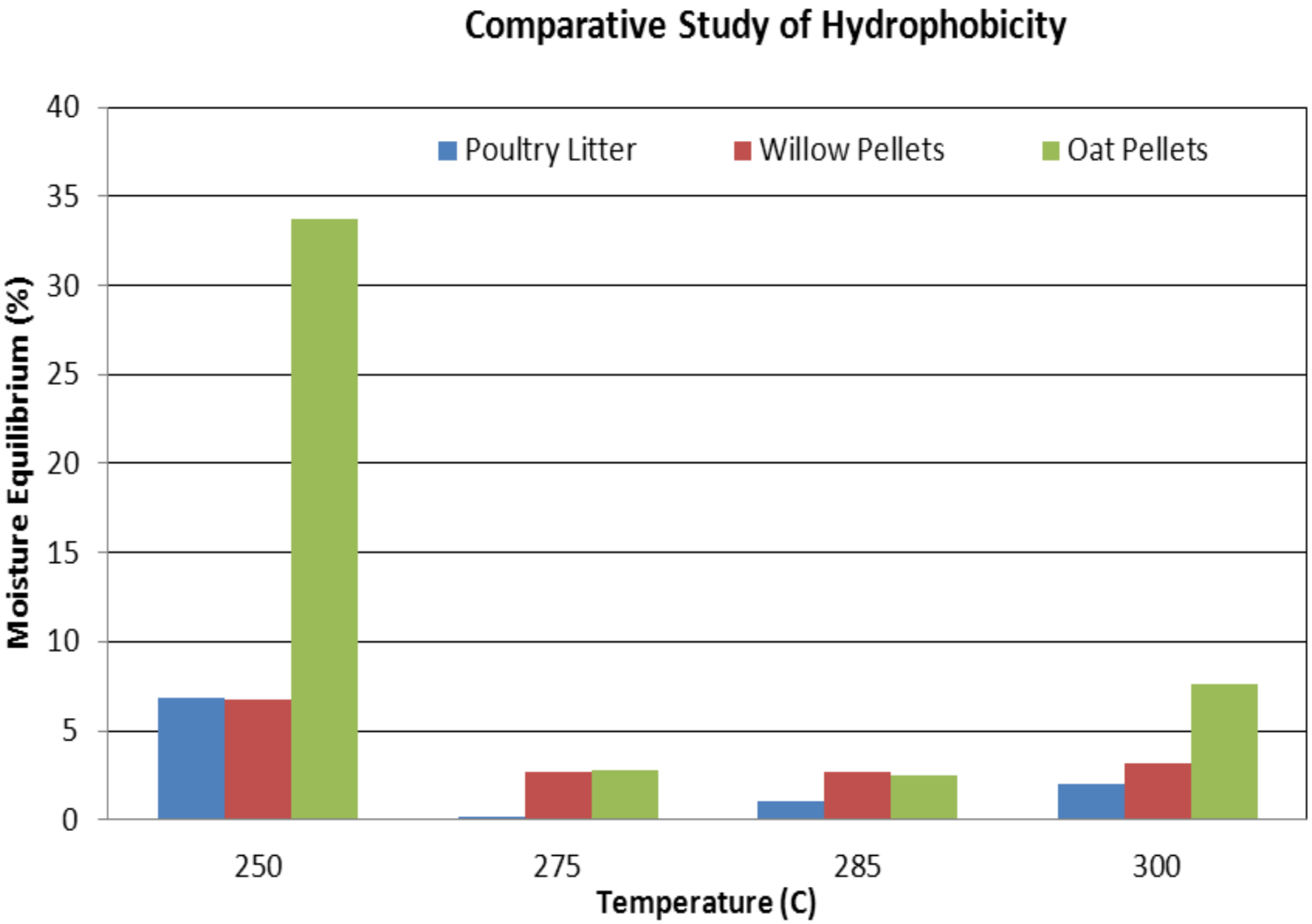
Experimental Result (Ultimate Analysis)



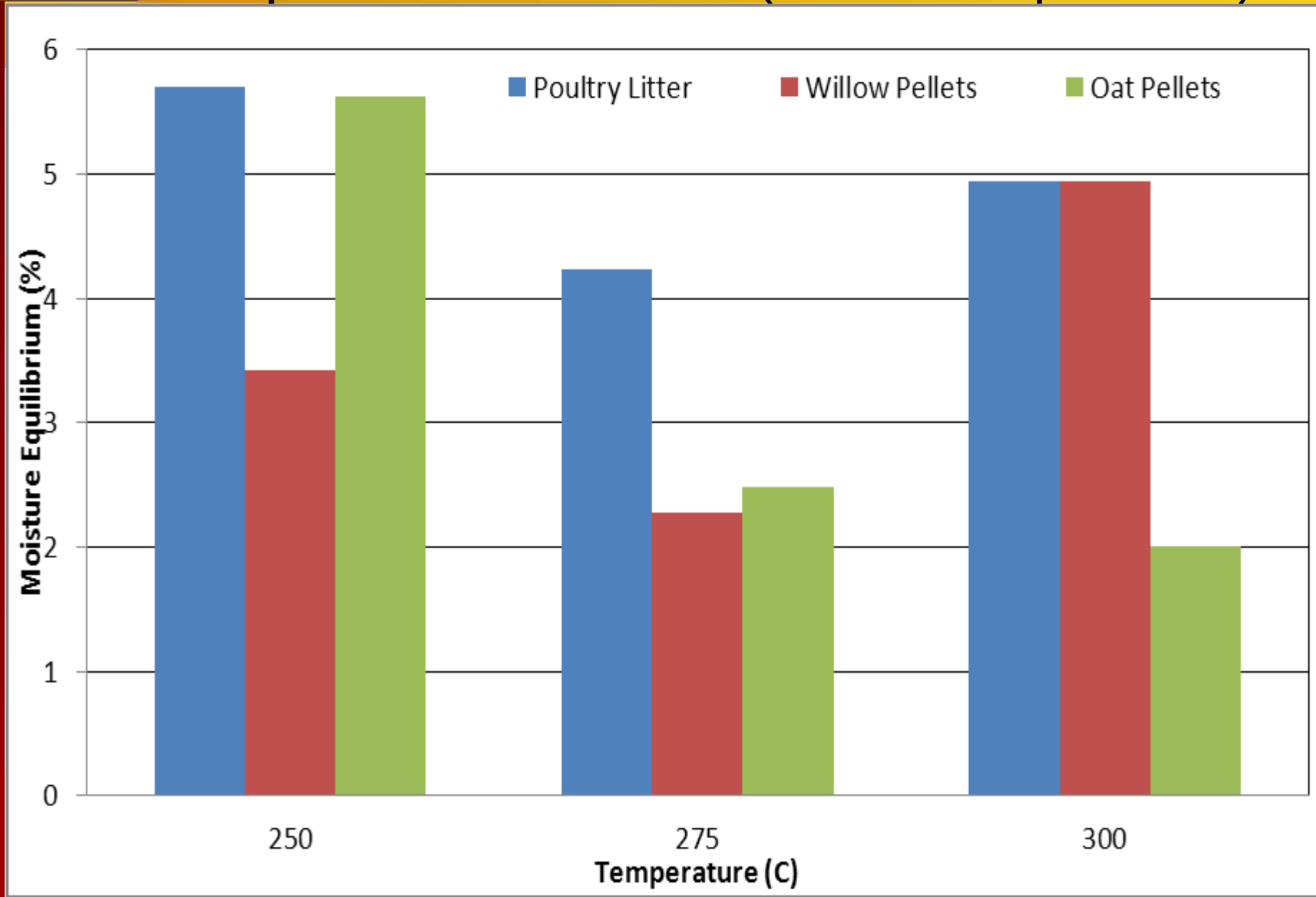
Experimental Result (HHV)



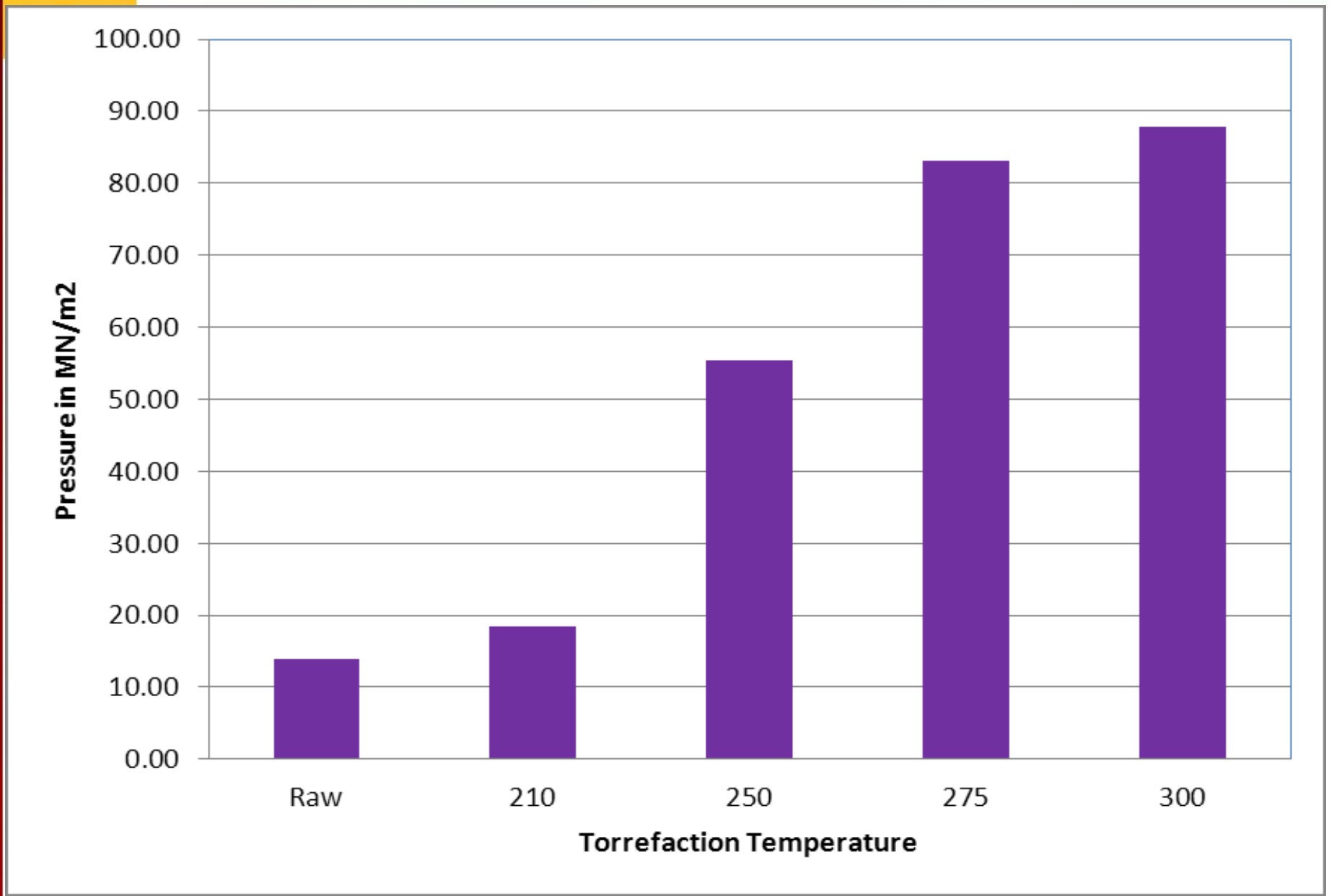
Experimental Result (Hydrophobicity-All)



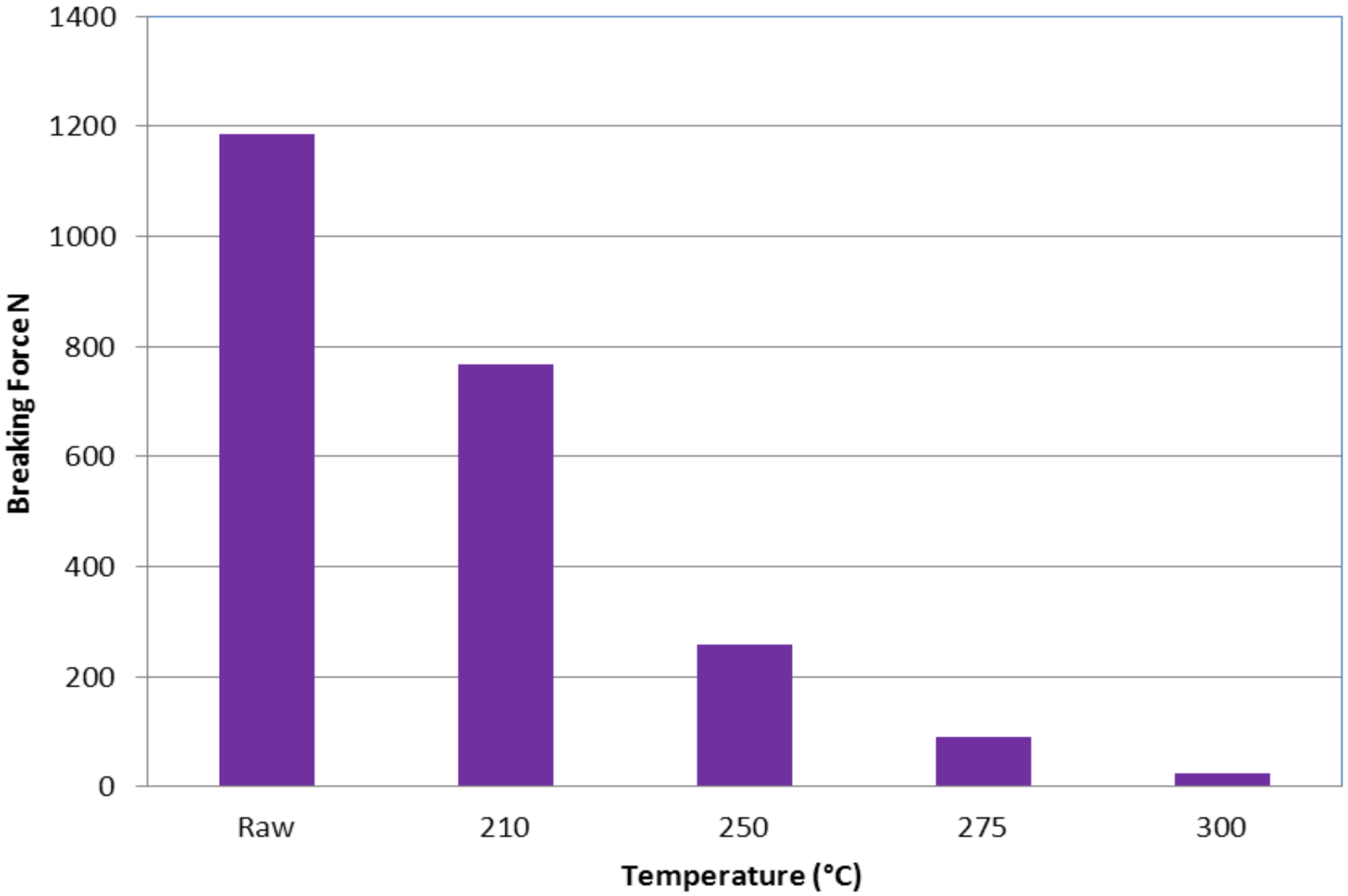
Experimental Result (Moisture Uptake-all)



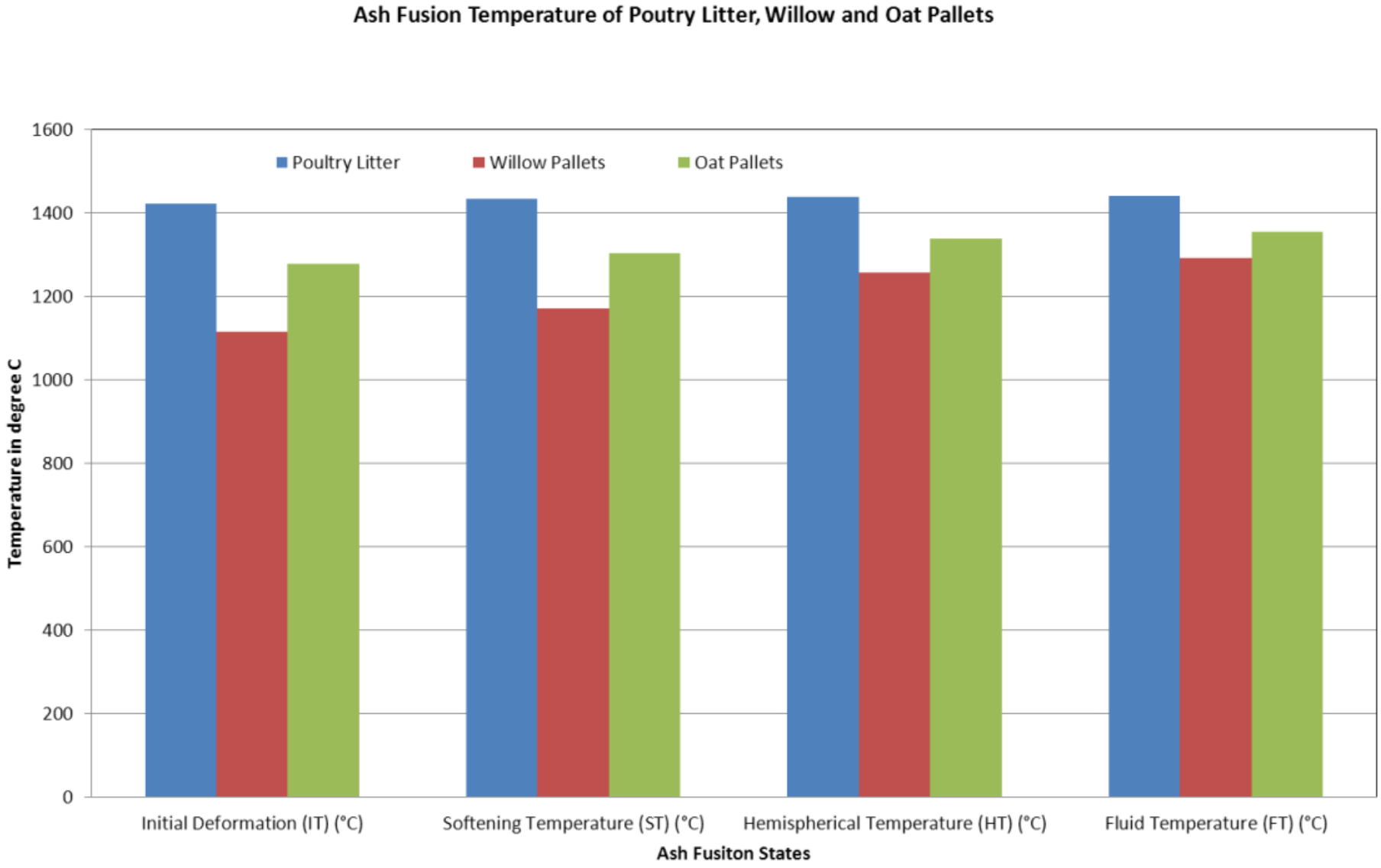
Experimental Result (Pelletization-Making)



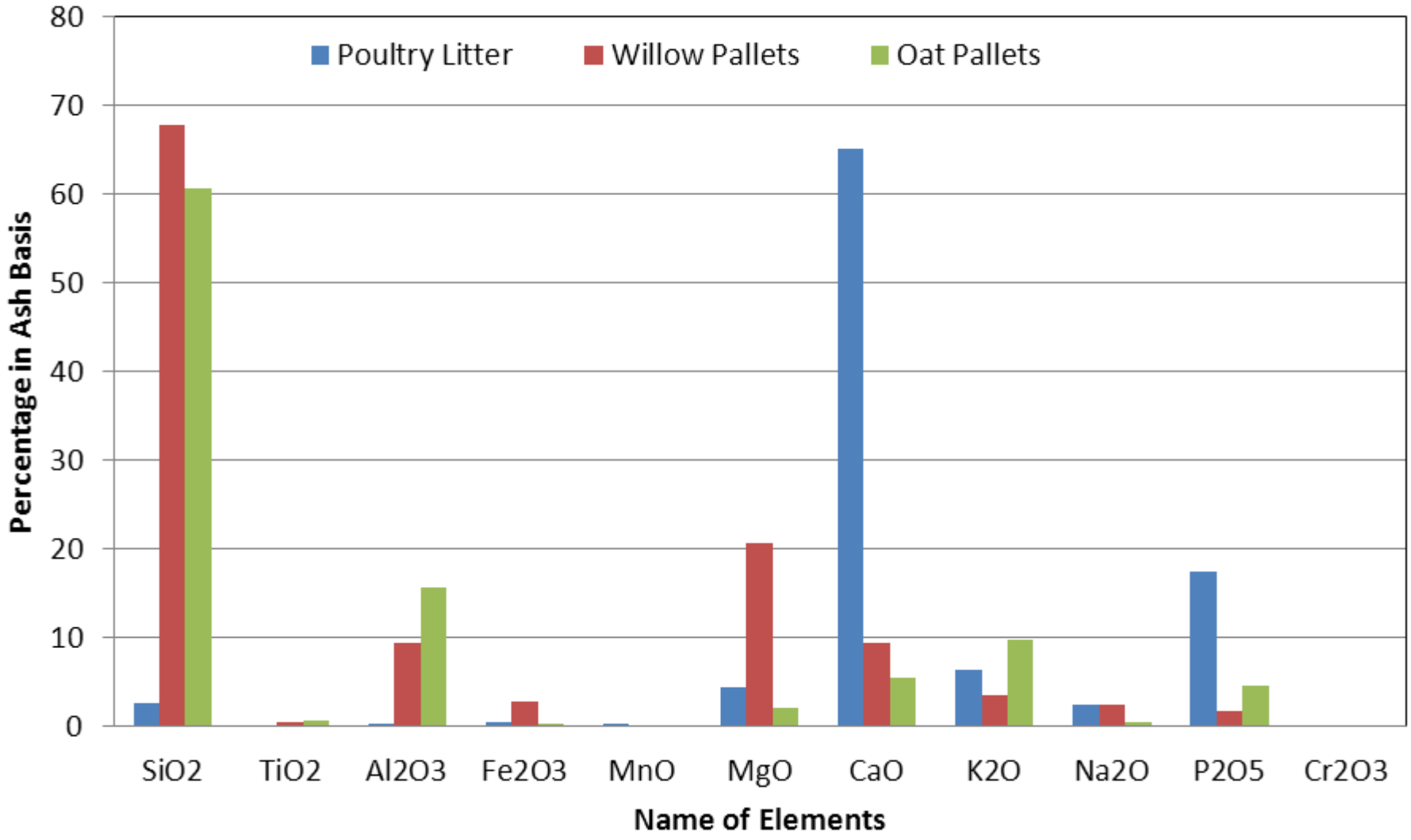
Experimental Result (Pelletization-Breaking)



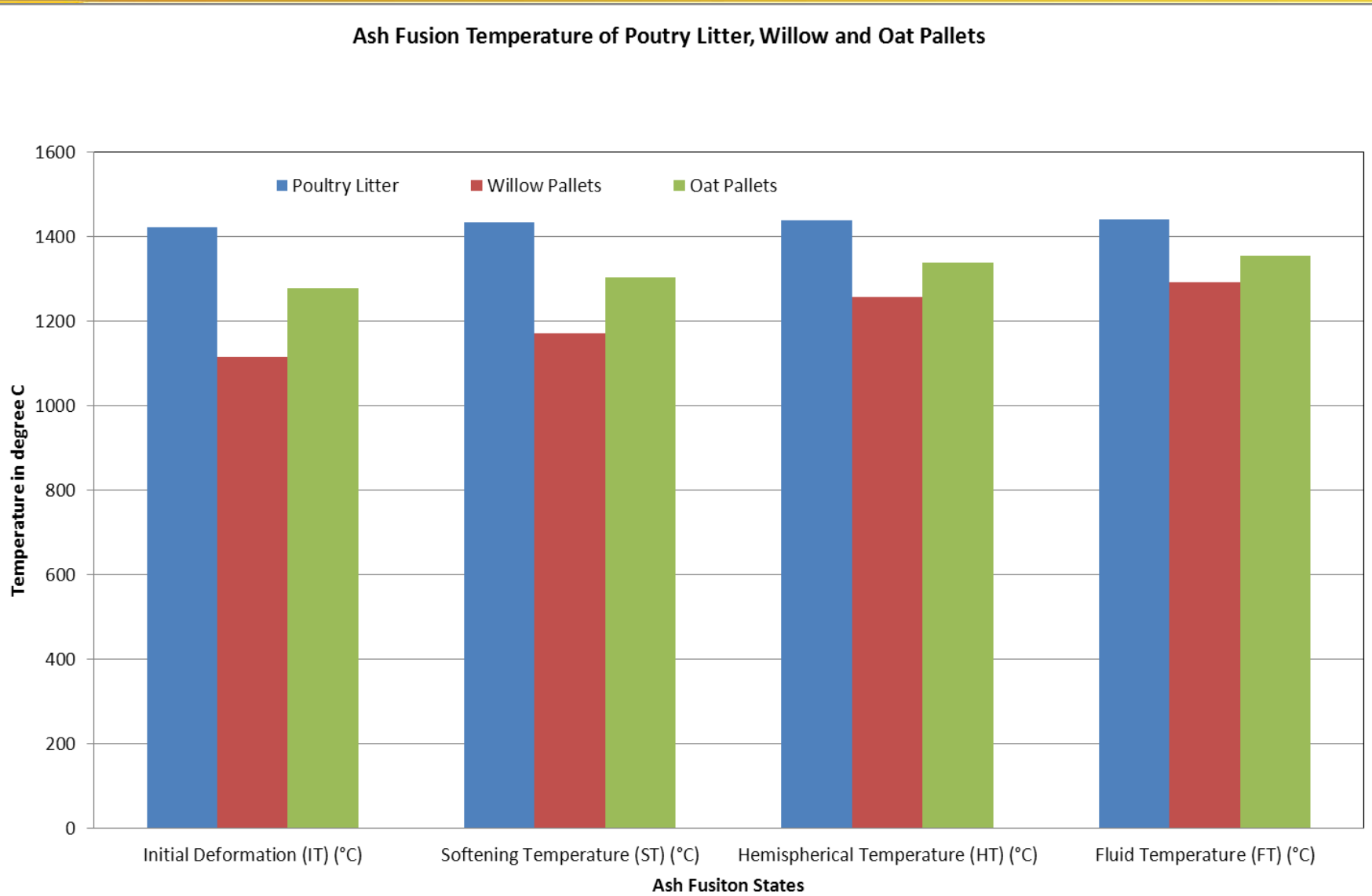
Experimental Result (Ash Fusion Temp)



Experimental Result (Elemental Ash Analysis)



Experimental Result (Ash Fusion Temperature)



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Applications

Residential and commercial heating

Power generation

- Biomass Co-firing in large scale coal-fired power plants
- Competes with coal in terms of price as well as performance
- Higher co-firing rates possible (compared to biomass)
- Most practical option to meet provincial mandate to phase out coal by 2014

Steel production

- TB with LHV in the range of 25 MJ/kg required

Biomass-to-liquid fuel

- Transportation fuels (Fischer–Tropsch process)

Export

- Large markets exist in US & Europe

Conclusions

	Coal	Torrefied Pellets
Heating Value	25 GJ/T	22 GJ/T
Ash	10%	3%
Sulphur	3%	0.1%
Nitrogen	1.5%	0.2%
Chlorine	0.05%	0.01%

- Torrefied biomass can be used for co-firing with coal in thermal power plant, heating system and combustion system.

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Conclusion

Characterization	Lignocellulosic	Non-Lignocellulosic
1. Mass Yield	Fast	Slow
2. Energy Yield	High	Low
3. Hydrophobicity	Yes	Yes
4. Moisture Uptake	Low	High
5. Pelletization	Possible	Possible only with binder
6. HHV	High 20-24MJ/Kg	Low 12MJ/Kg
7. Ash Composition	High Silica components	High Calcium component
8. Ash Fusion	Low 1100-1200ºC	High 1400ºC

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Recommendations

- Try to use torrefied biomass pellets for co-firing with coal in thermal power plant, heating system and combustion system.

- Run small businesses for pellet making: Raw and Torrefied both

- Need to explore further on economic viability and sustainability of the technology

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Thank you

Any Questions ?